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TRANSNET--A USER-ACCESSIBLE NETWORK OF TRANSPORTATION ANALYSIS MODELS*

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ABSTRACT

Models and associated data bases, developed under the sponsorship of the Department of Energy (DOE) through the Transportation Technology Center at Sandia National Laboratories, have been used to support transportation analysis efforts for specific sites and for the assessments of the impacts of transportation of specific waste forms to processing/storage sites. TRANSNET, an interactive computer network, was developed to allow outside users access to these models. TRANSNET contains the most recent versions of models developed under DOE/TTC sponsorship--code modifications that have been made since the last published documentation is noted to the user on the TRANSNET screens. To permit a greater spectrum of users to utilize the odels, considerable attention has been given to making the models user-friendly and in providing default data sets for typical problems. TRANSNET access and use is limited to support of DOE related program activities; for such activities there are currently no access or user charges.

The Transportation Technology Center (TTC) at Sandia National Laboratories is the Department of Energy's (DOE) lead organization for transportation research and development. TTC principally supports the DOE Office of Defense Programs and Office of Commercial Radioactive Waste Management. One of the task areas of the TTC is the development of analytical models to assist the DOE and others in assessing the impacts of the transportation of radioactive wastes and other radioactive materials. These models and techniques are used in environmental analyses, system design and operational assessments, equipment requirement estimates and budget exercises.

In the past, models and data developed by and under the sponsorship of the DOE/TTC have received limited distribution and use. In some cases, models or data developed to support transportation analyses either were not made available or the approval process for such availability was too lengthy and detailed to be truly responsive to the needs of other users. In other cases model development and refinement are continuing tasks, with the documentation process sometimes lagging actual code development.

In the first case, the principal sensitivity to distribution of the source code was largely a result of codes being developed to address the specific needs of the sponsoring organizations or that model development centered on research purposes and, as a result of the application of these techniques, significant changes to modeling methods and input data needs are required prior to application. Thus, it is often more efficient to make the model runs at the development site than to provide a copy of the source code which is consistent with the needs of the potential user.

The latter case is illustrated by model and development efforts underway at Sandia. The TTC routinely distributes formatted computerized tape copies of its risk assessment code entitled RADTRAN III. However, only versions incorporating fully documented updates are distributed. While such documentation is being developed, program sponsors often have needs for analyses that require further program refinements. Thus, the analyses often are released prior to the completed documentation. Particularly in the framework of the environmental analyses for construction of a facility or shipment of wastes, other potential users do not have ready access to the most current version of the code.

In order to address the needs of potential users for timely access to transportation analysis models and the associated data bases developed under the sponsorship of the TTC, a centralized computer network has been established that permits use of the models. Documentation and distribution of the source codes are thus left to the originating organizations and sponsors.

This network of transportation models has been given the acronym TRANSNET. The host computer, a MicroVAX II, resides at Los Alamos National Laboratories and is dedicated to the exclusive use of TRANSNET. Access to and use of TRANSNET are dedicated to noncommercial uses associated with DOE program activities. System access can be arranged through Sandia National Laboratories which reviews a potential users' planned application of the system and issues a password for a specified amount of time. Passwords will be reissued on a periodic basis for users requiring continuing access. There are currently no user access charges--just the telephone bill for the hookup period. The equipment required for access to TRANSNET includes an IBM-compatible personal computer, a Hayes-compatible modem and VTERM software.

Currently accessible on TRANSNET are RADTRAN III, INTERSTAT and FRTRATE. A summary of these models follows:

RADTRAN III--The RADTRAN III risk analysis model developed by Sandia National Laboratories calculates the radiological risks associated with the transport of radioactive materials (1) RADTRAN may be used alone for simple origin-destination

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calculations or can be used within a computational system to generate radiological unit-risk factors (risk per shipment-kilometer). The units of risk are radiological health effects, which include latent cancer fatalities and genetic effects in all generations.

The RADTRAN III code consists of two major modules: the incident-free transport module in which doses resulting from normal transport are modeled, and the accident module in which consequences and probabilities of accidents are modeled. Included in the incident-free module are models describing:

- offlink dose, i.e., dose to persons within 800 meters of the transport link (highway, railway or waterway);
- dose to persons sharing the transport link (onlink dose), which includes three submodels describing doses to persons in (a) vehicles traveling in the opposite direction, (b) vehicles traveling in the same direction, and (c) passing/adjacent vehicles, respectively;
- dose to members of the public at stops;
- dose to drivers, rail crews, etc. (occupational dose).

Each of these calculations is performed separately for each waste form and for each transport mode in each of three population density zones.

In the accident module of the code, the range of possible accidents can be divided into a maximum of 8 accident severity categories. The probability and consequences of accidents of each severity are specified for each important radionuclide in each waste form for each transport mode in each population density zone. The accident probabilities are derived from historical data for each mode. The consequences are calculated from the parameters describing the package, such as the radionuclide inventory of the contents (source term data) and the behavior of the contents under the specified accident conditions (fraction of material released, fraction of released material in aerosol form, etc.), and by the meteorological and exposure models contained in the code.

RADTRAN III differs from its predecessors in several ways. Important changes include (a) improvements in the rail-stop model, (b) inclusion of an ingestion pathway model in the accident analysis module, and (c) inclusion of a submodule in the calculation of onlink dose that accounts more correctly for adjacent/passing vehicles.

INTERSTAT - INTERSTAT is an automated modeling system developed at the TTC that permits the user to assess the impacts of route-specific data on the choice of highway routes. The INTERSTAT system includes two basic networks: the Interstate highway system (or designated state alternatives) and the NRC-approved routes for spent fuel shipments. Data associated with the route segments can be expanded to meet the specific needs of the user. INTERSTAT is entirely menu-driven and allows the user to forward the calculated route information directly to the RADTRAN input files for use in the risk calculations. INTERSTAT currently calculates routes based upon the minimization of either travel distance or population within one of two bandwidths along a route. The user is given detail of the calculated route as well as summaries of each of the parameters in the data base for the chosen path. Alternatively, the user can specify a route between the desired origin-destination pair and receive the parameter summaries for that route.

Other route-specific data are currently being identified and placed on the system. These additional data include accident data or surrogates, travel speeds, traffic volumes and geometric and structural characteristics. The system is being structured to allow the user the option of weighting the desired parameters prior to the route selection calculations.

FRTRATE - Under the sponsorship of the TTC, Battelle Pacific Northwest Laboratory (PNL) and Rockwell Hanford Operations compiled transportation shipping tariffs for spent fuel and radioactive wastes by truck and rail (2). Costs were broken into components for both loaded and empty shipments of radioactive waste packagings. The results of this study were computerized to permit user access through TRANSNET. FRTRATE (freight rate) models individual shipments of radioactive material from origin to destination as input by the user. The model estimates shipping costs, cask/package utilization and anticipated lease costs that may be incurred.

Each of the models described above has been written or modified to be run in a menu-driven fashion. The user follows screen prompts for available model or data options. For the largest of the models, RADTRAN III, the user has the ability to choose from data sets used by the TTC, modify parameters in those data sets, or create a file from scratch. The user is also permitted to create a personal data file for temporary storage of input and output files.

TRANSNET contains the most recent versions of models developed under TTC sponsorship--code modifications that have been made since the last publication of code documentation will be noted in the first few TRANSNET screens. Models being modified to incorporate the menu driven format prior to permitting outside access through TRANSNET include:

WASTES II--The WASTES II model was developed at Battelle Pacific Northwest Laboratories under the joint sponsorship of the DOE/OCRWM Monitored Retrievable Storage and Transportation programs (3). The WASTES II model is a logistics-related tool for use in analyzing the effects of various policy decisions and/or facility operating schedules of the commercial waste management system. WASTES II uses discrete event simulation techniques to model the generation of spent nuclear fuel, the buildup of spent fuel inventories within the system and the transportation requirements for the movement of wastes throughout the system.

The WASTES II model accepts up to a total of twelve facilities of four different types in addition to the pool and dry storage locations at the reactors. The allowable types of facilities are federal interim storage, monitored retrievable storage, reprocessing plants, and repositories. The minimum time that spent fuel must reside at each facility

may be specified. In addition, the minimum age since discharge or the maximum heat generation rate allowed for receipt at each facility may be specified.

The simulation is driven by a combination of source and destination requested transfers. Source-driven transfers would occur when a reactor pool exceeds its full core reserve storage margin or when a reactor is decommissioned. The material requiring transfer would be shipped to facilities with available capacity. Destination-driven transfers occur when the annual capacity of a facility will not be met by full core reserve or decommissioning shipments and fuel must be scheduled from facilities with non-critical storage needs. The order in which facilities ship to other facilities with available storage capacity may be specified by the user of WASTES II.

The user can specify whether shipments occur optimally, proximally or sequentially. Optimized shipping can be used when exactly two destination facilities exist. Optimized shipping selects source/destination pairs so that the total shipping distance in a given year is minimized. Proximity shipping fills the closest facility to the source according to the shipment priorities. This results in sub-optimal routing of waste material but can be used to approximate an optimal shipping strategy when more than two facilities of the same type are available to receive waste. In sequential filling of facilities, no attempt at optimization is made and the facilities are filled in a sequential manner based on an individual facility identification number assigned by the user.

RADCOM--RADCOM is a code which combines outputs from RADTRAN (unit-risk factors), WASTES (shipments), and INTERSTAT,RAILSTAT or BARGESTAT (transportation distances and population densities) to calculate total radiological risks. In addition, the RADCOM model calculates non-radiological risks of transportation from published mode-specific death and injury unit risk factors.

TRANSIT--In the process of screening various areas of the U.S. to determine potential sites for placement of a facility, the impacts of transportation must be examined as part of the formal evaluation process. Transportation impacts evolve from a variety of different considerations. These considerations include economics, public health and safety, environmental and socio-economic concerns. In the early stages of the screening process it becomes important to obtain a first order estimate of transportation impacts. PNL developed TRANSIT, a computerized model that evaluates the impacts of transportation upon siting, under the sponsorship of the TTC (4).

The TRANSIT model generates isopleths of transportation mileage, costs, risks, and fleet requirements for shipments to processing or storage sites utilizing existing data on the location and inventory of spent fuel or wastes at generator sites. These lines are derived from the number and location of the various sites that will ship waste within the U.S. and the amounts of waste that would be shipped within a given time frame. The model then overlays a set of grid points across the U.S. to establish equally spaced positions for potential facility locations. A weighted great circle transport methodology (applying circuity factors to more nearly approximate the actual route distance) to arrive at the total number of shipments, the weighted average cost per shipment, the weighted average risk (radiological, nonradiological and total) per shipment, and the the weighted average cask-use days per shipment are then calculated for each grid point. An interpolation routine establishes isopleths between the grid points for each of the values. This information may then be used to graphically display first-order estimates of the transportation impacts over time for the various regions of the U.S.

Four new models are currently under development for incorporation into TRANSNET:

RAILSTAT, BARGESTAT--The structured modeling system used for INTERSTAT will be used to describe networks for rail and barge. Data specific to the designated network will be included.

StateGEN, StateNET--To assist states and other entities to better understand the impact of state and/or local data on route choices, TRANSNET will include a modeling system, based upon the structure used to create INTERSTAT. There are two main components to the data/code structures assigned the acronyms StateGEN and StateNET. StateGEN provides the user with a basic network of Interstate and US highways within each state and allows the user to add additional state and local roadways, describe the network in greater detail as desired, and add route-specific data. StateGEN coding is designed to be downloaded from TRANSNET to a PC disk, thus allowing the user local access to the coding necessary to create a structured data base for the network of interest. Following creation of the network and attributes, TRANSNET will allow this data set to be uploaded.

Calculation of routing alternatives based upon user-specified weighting of route-specific parameters would be performed on TRANSNET by the StateNET model. This two-component methodology is designed to minimize user telephone hookup charges and increase TRANSNET system availability.

TRANSNET currently has users representing DOE contractor organizations and National Laboratories, the Tennessee Safe Growth Team, universities, states and state support groups. Sandia TTC and Los Alamos National Laboratory staff are available to further discuss and, where appropriate, demonstrate the capabilities of the TRANSNET system.

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